Mooring Modifications for the Reduction of Losses to Vandalism

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Mooring Vandalism

Outline

- Types of vandalism with examples.
- Regional distribution of vandalism
- Impacts on data return
- Modification of surface mooring hardware
- Modification of surface mooring design
- Modification of moored array
- Indian Ocean plans for 2008
- Development of longer term solutions

Types of Vandalism

- Incidental fishing interaction
- Intentional interaction (slingshotting)
- Theft
- Malicious damage

Incidental Fishing Interaction

Minor fouling of temperature sensor by longline. No impact on data.
Can be hazardous to personnel.

Incidental Fishing Interaction

- Fouling of Doppler Current Meter with longline and float
- Potential impact on data quality.
- Damage to connector and electrical cable.

Incidental Fishing Interaction

Longline completely engulfs instrument.

Cuts to wire jacket can cause failure of data telemetry.

Incidental Fishing Interaction

Large amounts of longline can increase drag on mooring

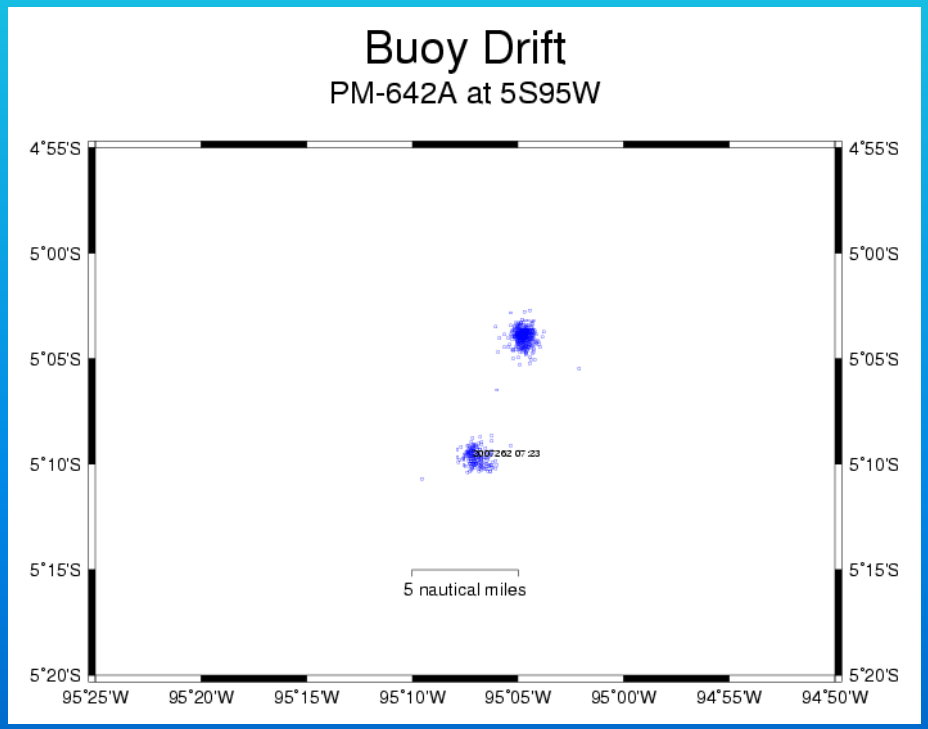
Incidental Fishing Interaction

Fishing line can contain unexpected bi-catch.

Intentional Fishing Interaction

Purse seiners slowly pull buoys several miles, setting their nets around the buoy and the fish attracted to the “FAD”. They then release the buoy and close the net. This “sling shot” method increases their catch, but can damage moorings to the point that they are separated from their anchors.

Image credit: Gulf of Maine Research Institute
http://www.gmri.org

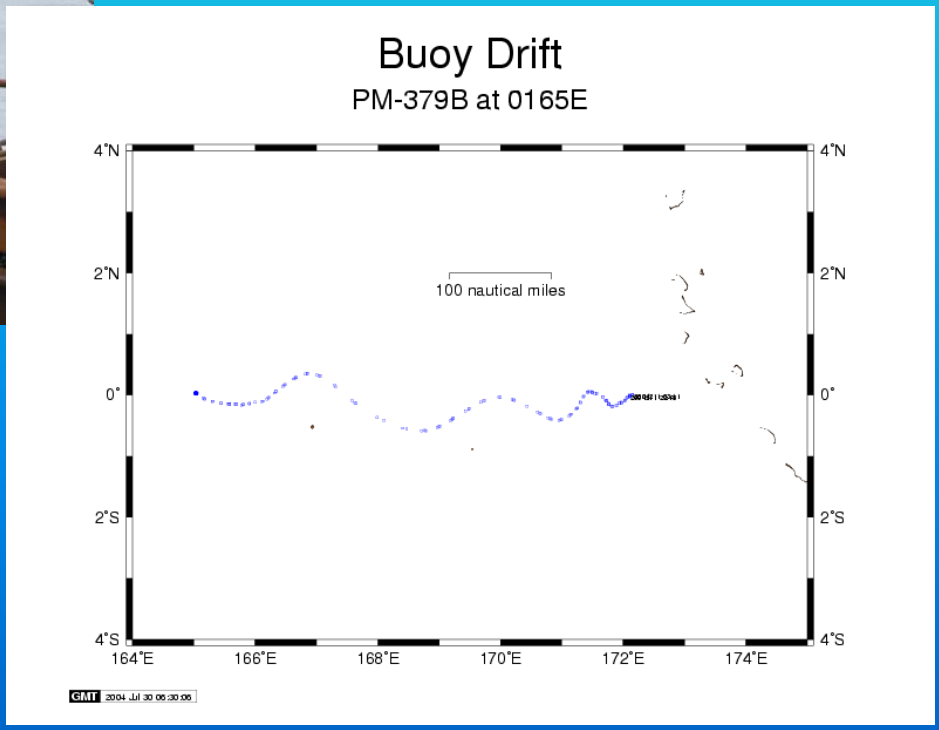


Intentional Fishing Interaction

June-July 2004

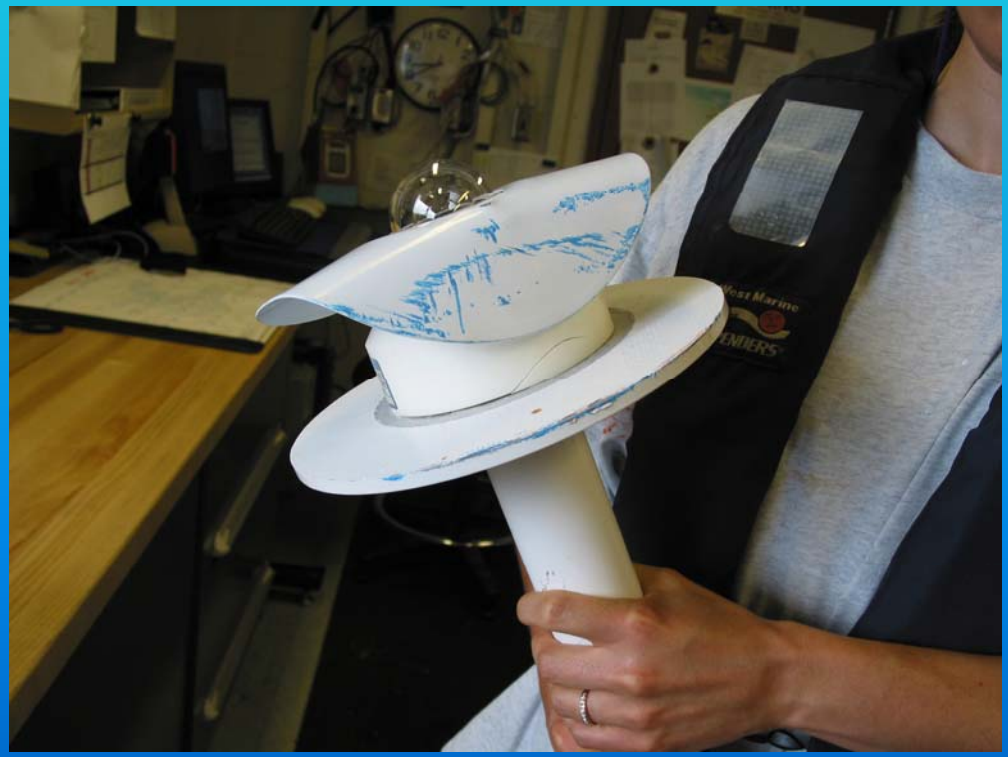
0º 165ºE

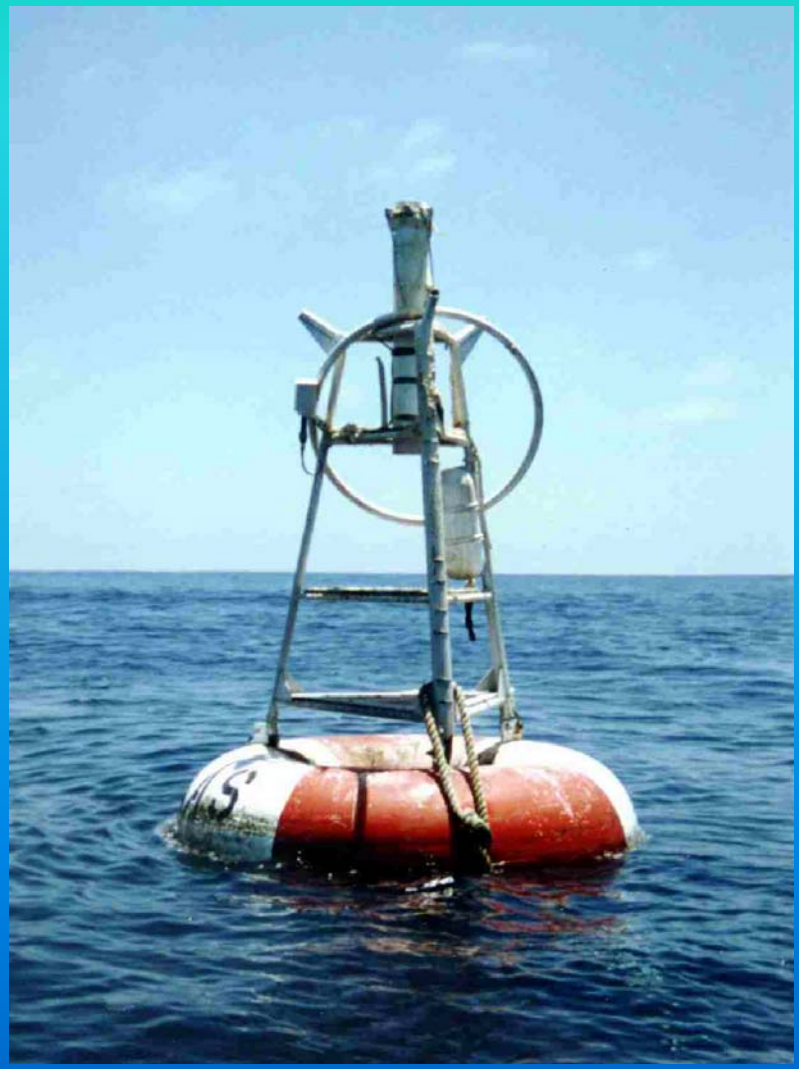
Mooring drifted for 2 months before being recovered. Had hawser attached.



Intentional Fishing Interaction

- Damage to buoy and sensors can occur when large ships tie up to moorings

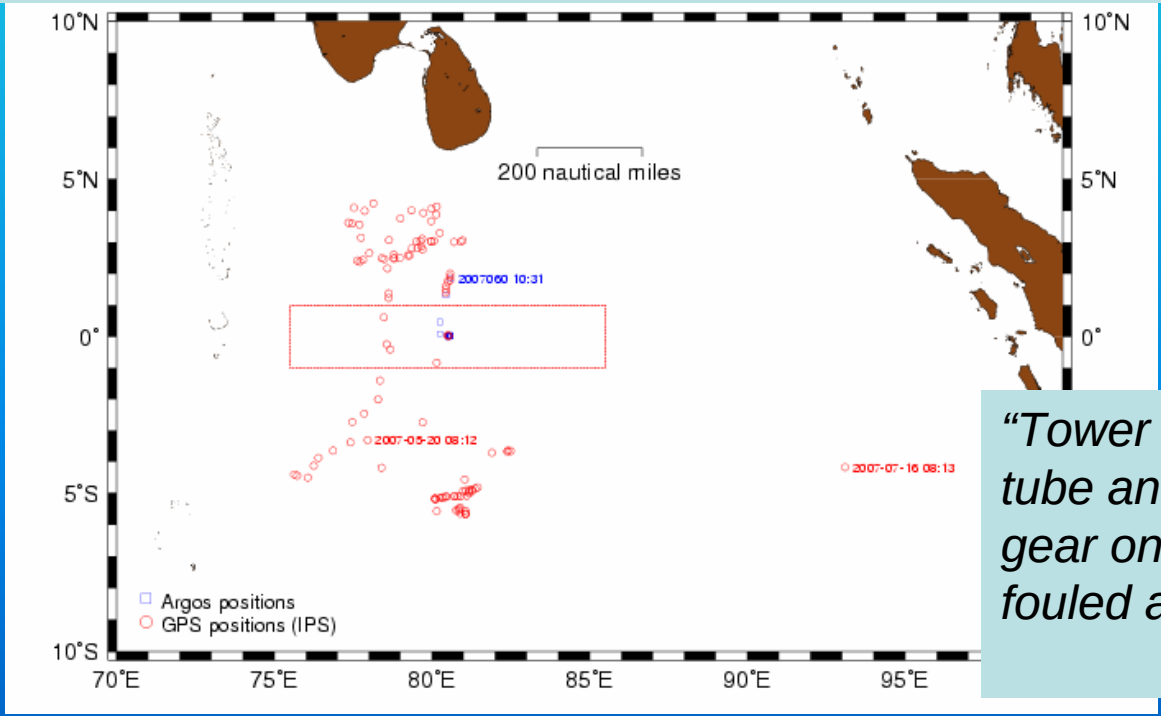




Theft of equipment

"Hi There,
I believe you are wanting back an electronic tube that I have which I found drifting about 18 month ago. I am willing to give it back but need compensation – how much are you prepared to pay?"

Email from Palmerston Atoll



"Tower stripped of sensors, except tube and barometer, lots of fishing gear on bridle, plus float. Fishing gear fouled at 10m, 20m, 50m, 100m."

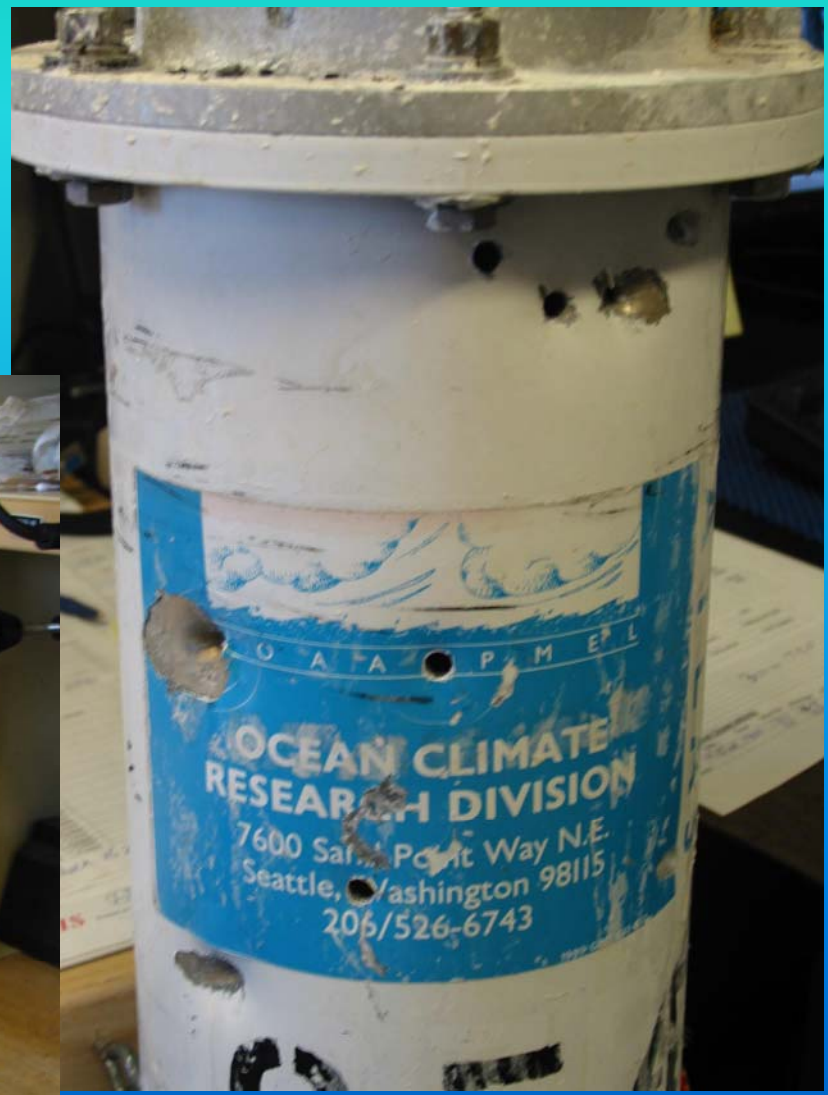
0º 90ºE Mooring Recovery Log

Malicious Damage

All or a portion of the buoy tower may be removed, either by unbolting or cutting.

Malicious Damage

Buoys have been used for target practice.



TAO Vandalism 2000-2007

Moorings and instruments confirmed lost or damaged (through August 2007).

	Number Deployed	Number Lost	Number Damaged	Percent Lost	Percent Damaged
Moorings	**493**	**34**	**27**	**7%**	**5%**
Wind	**597**	**122**	**32**	**20%**	**5%**
Air Temperature	**565**	**64**	**10**	**11%**	**2%**
Short Wave Radiation	**195**	**31**	**16**	**16%**	**8%**
Rain	**321**	**46**	**28**	**14%**	**9%**
Barometric Pressure	**90**	**22**	**0**	**24%**	**0%**
Long Wave Radiation	**65**	**17**	**5**	**26%**	**8%**
Water Temperature	**>5423**	**>436**		**~8%**	

All surface sensors: 16% lost, 5% damaged.

All sensors: 10% lost.

PIRATA Vandalism 2000-2007

Moorings and instruments confirmed lost or damaged (through August 2007).

	Number Deployed	Number Lost	Number Damaged	Percent Lost	Percent Damaged
Moorings	**80**	**4**	**6**	**5%**	**8%**
Wind	**80**	**14**	**6**	**18%**	**8%**
Air Temperature	**80**	**8**	**3**	**10%**	**4%**
Short Wave Radiation	**79**	**10**	**6**	**13%**	**8%**
Rain	**80**	**8**	**10**	**10%**	**13%**
Barometric Pressure	**3**	**0**	**0**	**0%**	**0%**
Long Wave Radiation	**3**	**0**	**0**	**0%**	**0%**
Water Temperature	**>880**	**>66**		**~8%**	

All surface sensors: 12% lost, 8% damaged.

All sensors: 9% lost.

Indian Ocean Vandalism 2004-2007

Moorings and instruments confirmed lost or damaged (through August 2007).

	Number Deployed	Number Lost	Number Damaged	Percent Lost	Percent Damaged
Moorings	**11**	**4**	**0**	**36%**	**0%**
Wind	**13**	**6**	**1**	**46%**	**8%**
AT	**13**	**6**	**0**	**46%**	**0%**
SWR	**12**	**5**	**1**	**42%**	**8%**
Rain	**12**	**5**	**1**	**42%**	**8%**
BP	**3**	**1**	**0**	**33%**	**0%**
LWR	**2**	**1**	**0**	**50%**	**0%**
Temp modules	**~132**	**~46**		**~35%**	

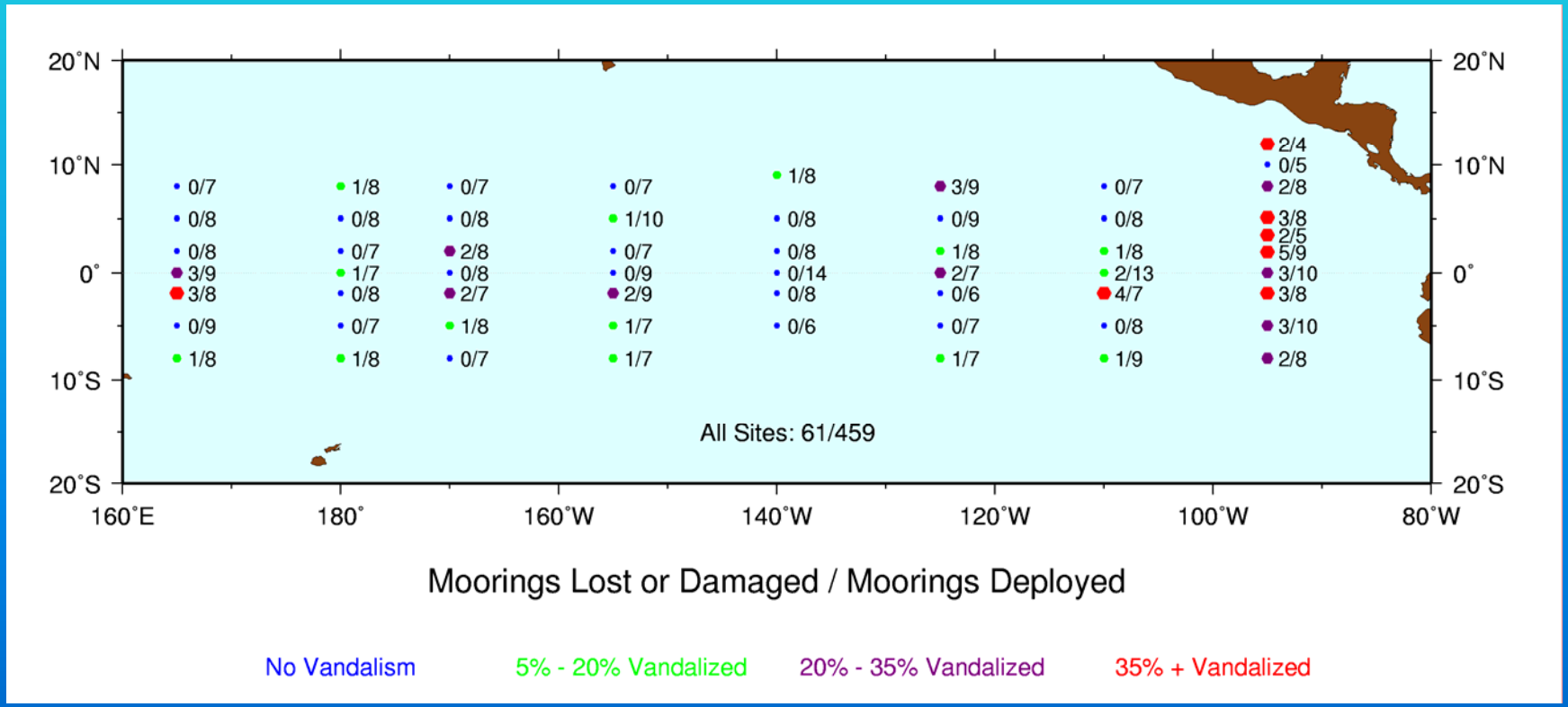
All surface sensors: 44% lost, 5% damaged.

All sensors: 37% lost.

Major TAO Vandalism 2000-2007

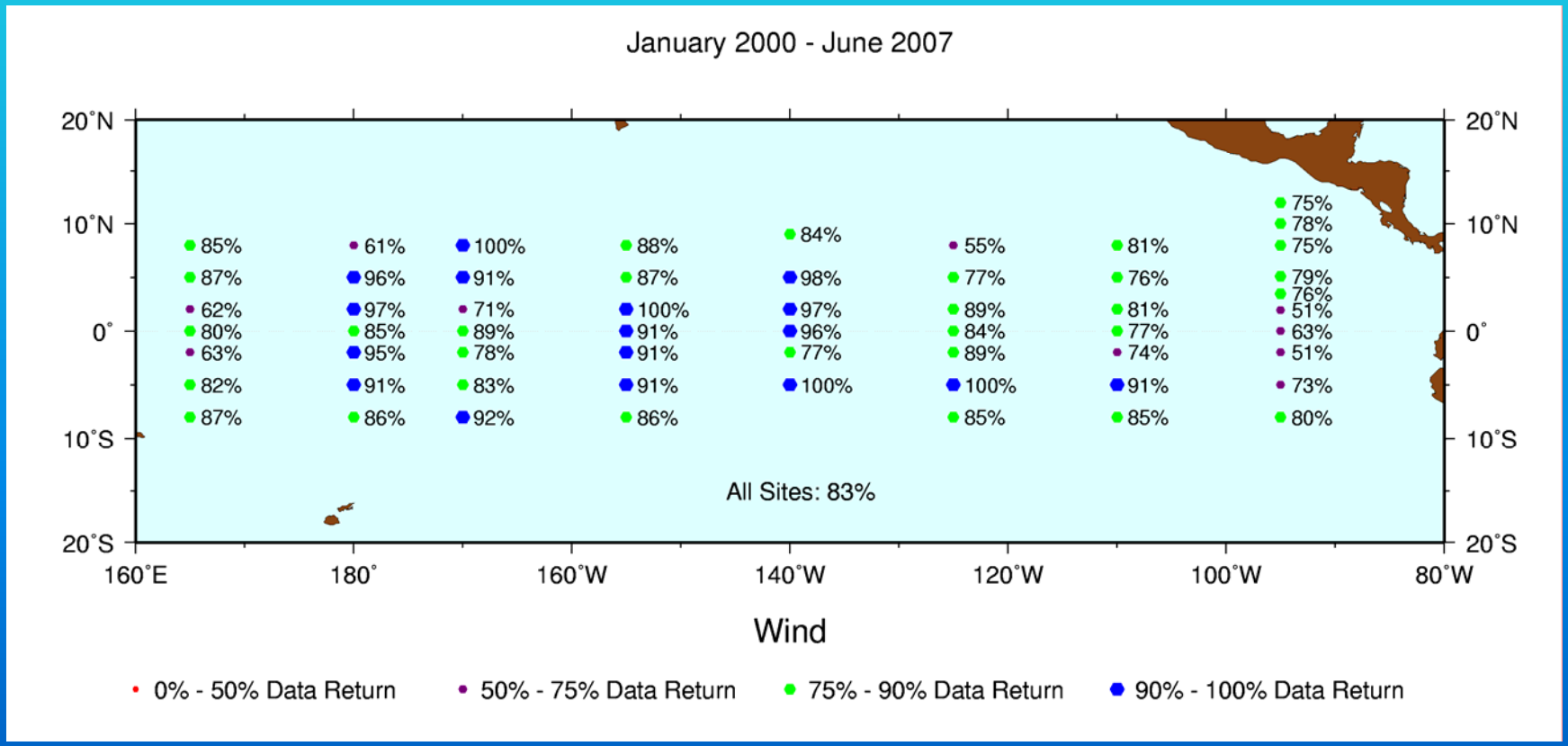
Moorings which were entirely lost, or all surface or subsurface sensors were lost.

Majority of major vandalism was mainly in eastern portion of the Pacific Basin.



TAO Data Return

- Wind sensor is one of the most often vandalized.
- Pattern of data loss is consistent with pattern of vandalism.
- Data return for all standard sensors was 91%.



Indian Ocean Mooring Design Modifications
2007-2008

- **Make sensors and equipment more difficult to remove**
- **Remove vulnerable sensors**
- **Make buoys harder to board**
- **Remove buoy attachment points**
- **Deploy more subsurface moorings**

Vandal Resistant Hardware

Hardware used to attached sensors and the buoy tower will require special tools.

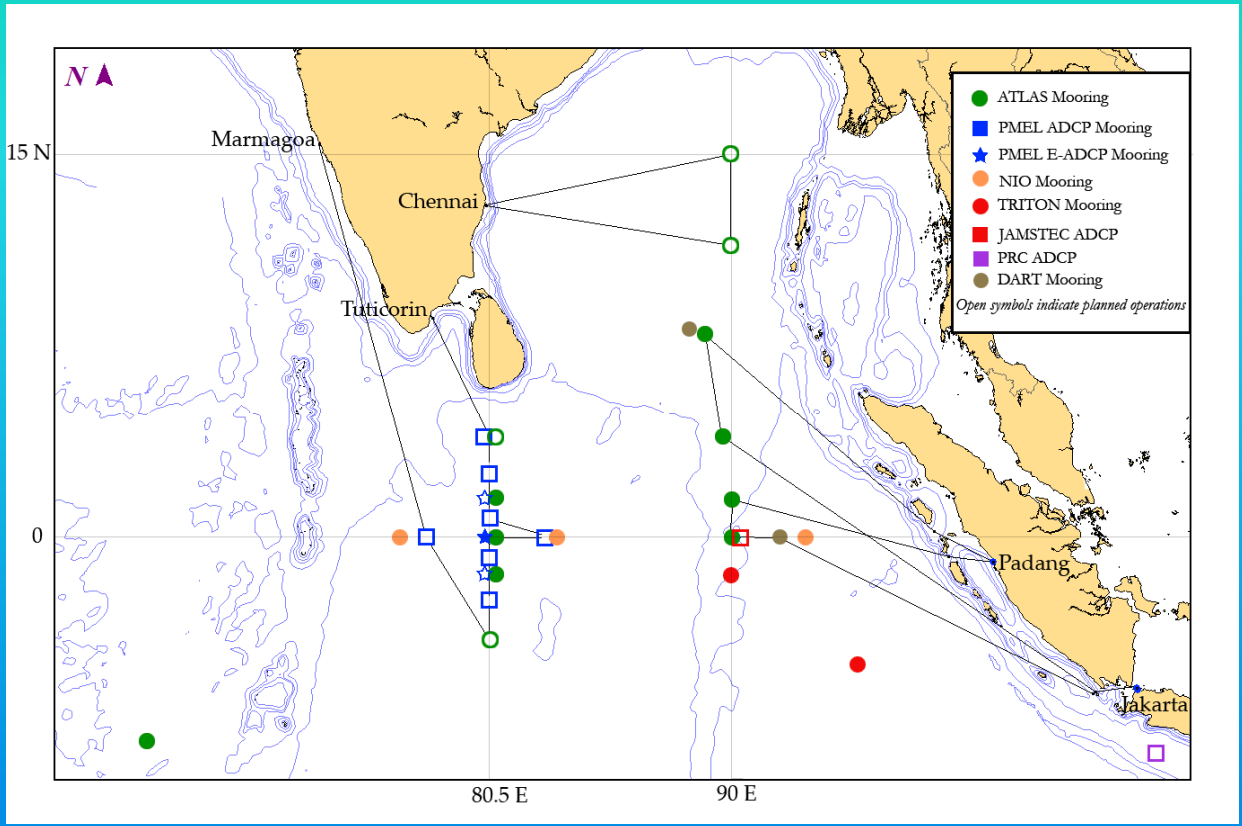
Vandal Resistant Buoys

Surface sensors and tower removed. Buoy covered with cone to inhibit boarding or attachment to buoy. SST, SSS, subsurface T and S, and velocity measurements remain and telemetered via Argos. If prototype moorings are not vandalized, new vandal resistant surface sensors could be reintroduced.

Vandal Resistant Buoys

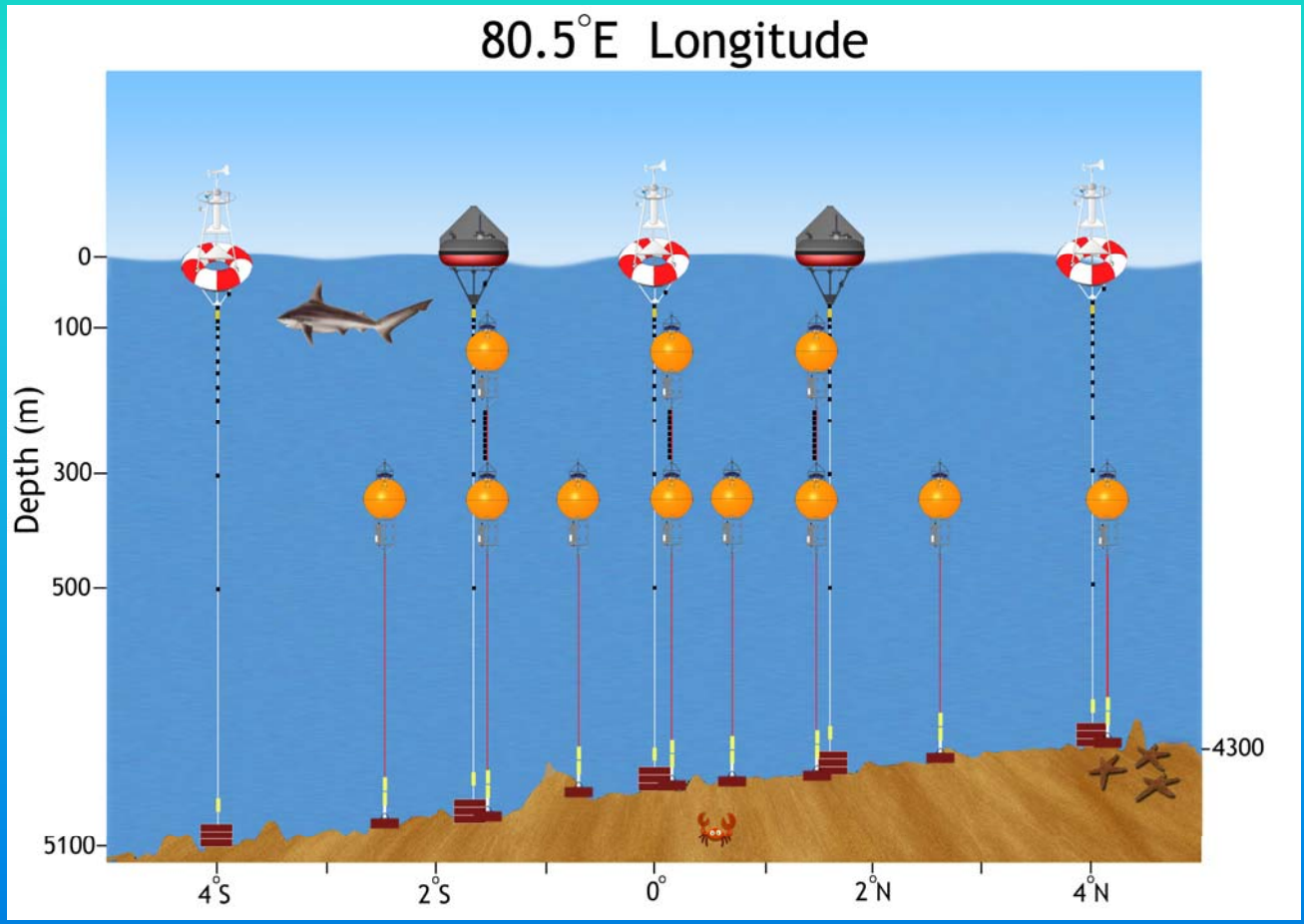
New recovery and deployment methods are required and are under development

2007-2008 Indian Ocean Plans



- Surface moorings will either have vandal resistant hardware or “conehead” design. Prototype deployments began in September 2007.
- New ATLAS sites to be deployed in Bay of Bengal.
- Expanded array along 80.5 ºE will include additional off-equatorial ATLAS surface moorings and additional subsurface ADCP moorings.

2008 Indian Ocean Plans



Expanded ADCP array along 80.5 ºE will include some moorings enhanced for upper ocean T and S measurements. Two surface moorings will have vandal resistant design.

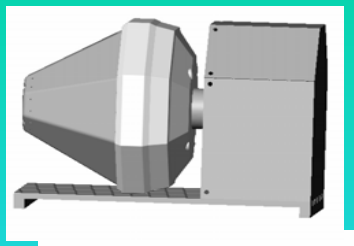
Future Mooring Design Goals

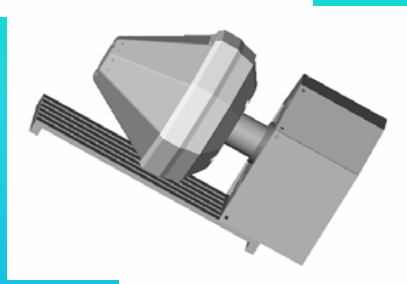
- **Telemeter more data**
- **Reduce size/cost of mooring hardware**
- **Reduce size/cost of sensors**
- **Reduce vulnerability of sensors**
- **Reduce cost of shipping and deployment**

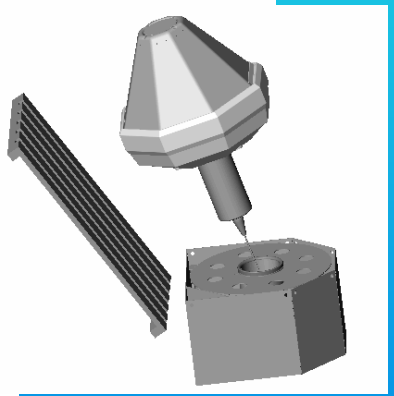
PICO

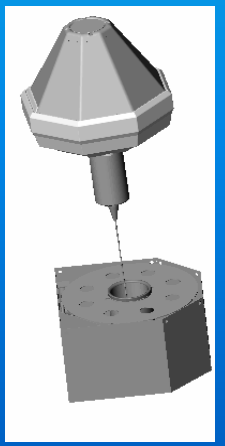
(Platform and Instrumentation for Continuous ocean Obs)

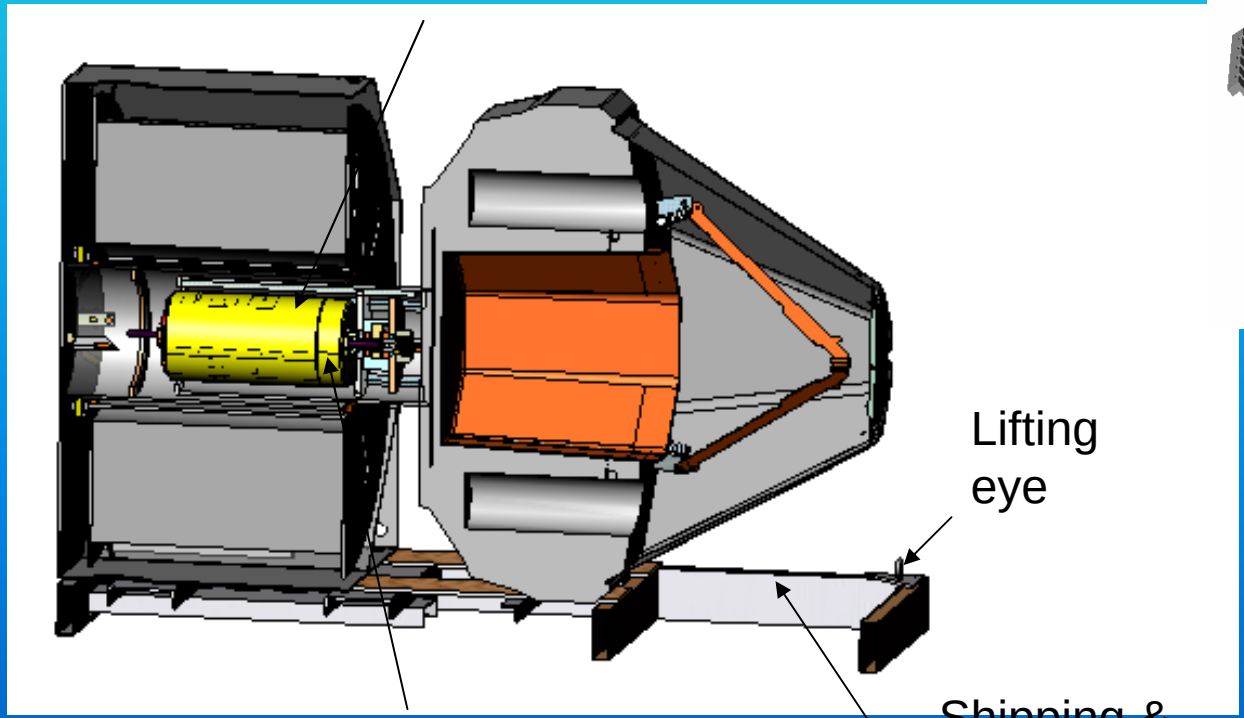
- Pre-packaged and palletized
- “Factory-built” concept
- Small vessel
- Low Expertise
- Cost effective









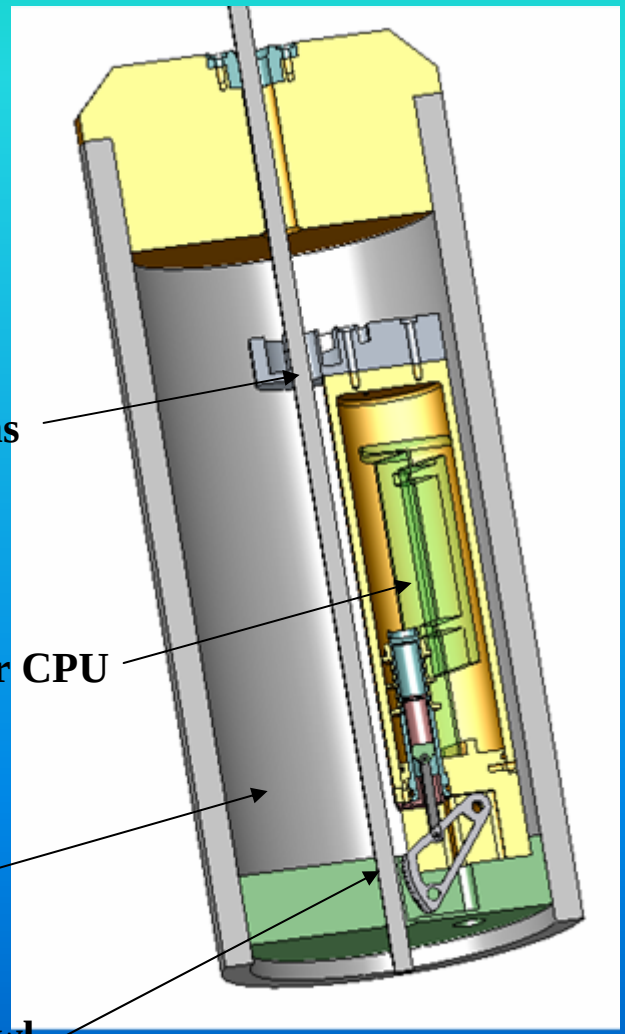


R&D Engineering

“Prawler” (Profiler + Crawler)

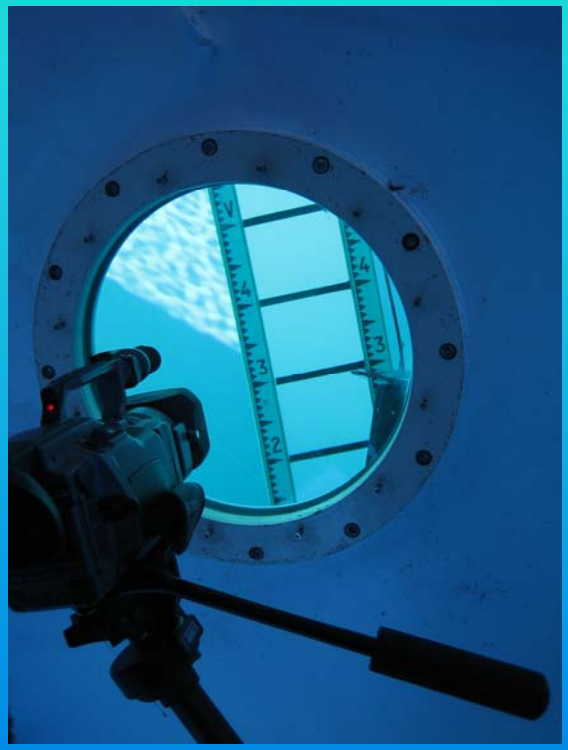
- PURPOSE:
- Test a simple ascender concept for climbing the mooring line:
- Develop an efficient magnetic ‘actuator’
- Develop and test software adaptive sampling routines.
- Quantify ascent and decent under measured surface displacements.

- FIELD TRIALS:
- Terminal fall velocity set at .3 m/sec
- Successful tests in 60m local waters with manual wave input.
- Achieved ~85% efficiency in climbing with 1m 6sec wave input.



R&D Engineering

“Prawler” Testing



10m tank testing

Buoy and Prawler deployment

R&D Engineering

Summary

- Damage to moorings by fishermen, either inadvertent or intentional, results in significant loss of both data and equipment.
- Percentage losses are especially high in the Indian Ocean.
- PMEL is redesigning its surface moorings in an attempt to reduced loss of instrumentation and data, and relying more heavily on subsurface moorings.
- The first deployments of vandal resistant moorings in September 2007.
- Some modifications will result in less surface data, and less data in real time.
- If these modifications reduce the damage and losses of moorings, then (lower cost?) vandal resistant sensors may be added to the moorings.
- Longer term mooring solutions which adopt unique technology are being developed.
- Modifications which prove successful may be extended to other basins.